



Commercial Microcircuit Best Practices Report

NAVSEA – Crane
Component Engineering Branch
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Background

Department of Defense Acquisition Reform

The Department of Defense has adopted a vision of becoming a world-class buyer of best value goods and services from a globally competitive industrial base.

Navy Acquisition Reform Principles

1. ***Use Commercial Products, Practices, and Processes*** to the maximum extent practicable (e.g., EIA-JEDEC standards and committees, automotive and communication products, and SPC and process controls instead of screening).
2. ***Reliability and Maintainability (R&M)*** establishes the basis for a comprehensive effort designed to assure meeting mission needs and reducing life-cycle ownership costs.

The Navy has attempted to minimize its reliance on MILSPECs and STDs for R&M through the use of guideline documents developed cooperatively with industry experts, based on sound engineering principles and providing technical guidance.

The acquisition reform of the Navy developed the following reliability and maintainability information to look for when preparing a request for proposal (RFP) or statement of work (SOW).

- a. A design-reference mission-profile to establish adequate and complete performance requirements. This should include functional and environmental profiles that:
 - 1) Define the boundaries of the performance envelope.
 - 2) Provide the timelines (i.e., environmental conditions and applied induced stresses over time) typical of operations within the envelope.
 - 3) Identify all constraints (e.g., conditions of storage and maintenance).
- b. Requirements for the contractor to identify mission or safety critical single point failures and the steps he will take to avoid them.

- c. Requirements for the performance of parts stress analysis and testing to verify compliance with agreed to derating criteria under worst-case mission profile environments. The parts derating criteria should be mutually agreed upon between the contractor and the government, taking into consideration past component history, environmental stresses, and component criticality.
- d. Requirements for the contractor to show that commercial and nondevelopmental items will be operationally suitable for their intended use and capable of meeting their allocated reliability and maintainability requirements.
- e. Shown below is excerpts from the Navy's sample RFP checklist.

Sample Reliability and Maintainability

RFP Checklist

RELIABILITY AND MAINTAINABILITY	YES	NO	WAIVER
REQUIREMENTS: <i>Reliability Program</i> <i>Maintainability Program</i> <i>Availability</i>			
DESIGN DISCIPLINES: <i>Stress Analysis</i> <i>Worst Case Analysis</i> <i>FMEA</i> <i>Thermal Survey</i> <i>Parts Derating</i> TEOOO-AB-GTP-010			

<i>Predictions</i>			
<i>MIL-HDBK-217</i>			
<i>ESD Control</i>			
<i>MIL-STD-1686</i>			
<i>Commercial Practice</i>			
TESTING:			
MANUFACTURING:			
<i>Environmental Stress Screening (ESS)</i>			

3. **Warranties** – Acquisition reform principle of risk management and maximum use of commercial processes suggests warranties should be limited to those already in use by industry, and a cost/risk assessment be undertaken for any proposed “government unique” requirement.

Look for:

- a. Use of existing warranties offered by industry or other government customers instead of unique government warranty.
- b. Specified reliability requirements consistent with technology advances and determination that state-of the-art reliability provides realistic objectives and thresholds for specification requirements.

4. **Performance Specifications** – Acquisition reform is striving to reduce Government risk by using performance based specifications and standards. This makes the contractor responsible for providing the item or service requested and assuming the risk for meeting performance requirements. In addition, the contractor can seek innovations to efficiently and effectively achieve performance objectives.

Look for requirements derived from a higher level requirement, i.e., specific environment and application requirements.

5. **Risk Management** – Acquisition reform seeks to move from a risk adverse to a risk management philosophy. This is to streamline processes, reduce oversight and control, and seek to reduce cost.

It is the responsibility of the contractor to control the manufacturing processes and verify conformance to the detail design and technical requirements of the technical data package. The quality assurance provisions in the technical data package serve to verify conformance of the parts and components of the system.

6. **Testing**– Test and evaluation begins when a concept to fill a military need is first identified and continues throughout the development and operational life of the system.

Look for:

- a. Requirements for sufficient testing on commercial and non-developmental items to ensure performance, operational effectiveness, and operational suitability for the military applications.
- b. Test program tailoring to recognize previous commercial testing and experience.
- c. Modeling, simulation, and process control techniques instead of development and production testing.



Microcircuit Usage in Military Applications

The NAVSEA Part Requirement & Application Manual, TE000-AB-GTP-010 Revision 2, complies with acquisition reform policies and principles established by DoD.

DoD acquisition reform policy guided and directed these positions stated herein.

1. **Selecting Microcircuits**

- a. DoD does not have a selection process (e.g., QML first, military SCD second, industrial third and commercial fourth).
- b. The policy is to use the best commercial products to get the best value.
- c. The application establishes performance and environmental requirements, a reliability plan and then selects the best value microcircuit for the application.
- d. DMS, legacy and maintenance part selection should be done somewhat differently than with new design. The government usually owns this legacy equipment, the configuration is set and the product is mature or diminishing. By contrast, a contractor controls the new design and has broad flexibility in selecting product. DoD needs to develop a road map so these selection processes come together as one. *Logistic support* is essential in developing this road map which balances commercial concepts with application life needs.

2. **Uprating Microcircuits**

- a. DoD acquisition reform says to use the best commercial practices. For the design-discipline of characterizing for a specific application, *derating* the microcircuit within the application is the best practice.
- b. The acquisition reform reliability-principles of the Navy require part derating, stress analysis and a thermal survey. *Uprating* is not required and adds no value. There will be an added cost to *uprate* - screen and a risk of over-stressing the parts. In addition, the acquisition reform risk management principle requires an added cost justification.
- c. A microcircuit manufacturer lists ratings, characteristics, and temperature limitations by technology and package style. The manufacturers, for application usage, list derating curves. They do not address *uprating* for application selection.
- d. The equipment manufacturer industry (e.g., military, automotive, and computer) design by *derating* microcircuits to applications. They do not design or establish reliability by *uprating*.

- e. No scientific body recognizes the term *uprating*.
- f. The definition of *uprating* “a process to assess the capability of a component to meet the performance requirements of the application in which the component is used outside the manufacturer’s specification range” is broad and vague.

3. *Using a microcircuit in a higher temperature application than its data sheet range.*

- a. This had been unacceptable. It breaks design disciplines, the part’s data sheet temperature ranges, and reliability and maintainability requirements.
- b. This is beginning to be done in the design-selection process. The way to do it is to maintain strict commercial best practice principles.
- c. When design selecting, do so to the part’s true-characteristics, not the data sheet limitations.
- d. A part’s data sheet range may be exceeded, as long as the part’s junction temperature and maximum parameter characteristics are never exceeded. Derating the part’s power dissipating parameters is the best practice to control the junction temperature.

4. Screening microcircuits to be used outside their designated data sheet range.

- a. This breaks many of the acquisition reform principles (e.g., best commercial practices, products, and processes, and reliability and maintainability principles).
- b. Thermal – characterization, to JEDEC Standard 51 Thermal Test Method, is the best commercial practice to characterize parts. The application temperature with the part’s junction temperature can easily be calculated to determine the part derating. This test method is precise and repeatable in measuring a part’s junction temperature at different airflow temperature conditions. The test equipment can easily be setup at a lab to assess a part’s thermal characteristics.
- c. Whatever screen is used, it has to be a repeatable measurement of the part’s junction temperature and a non-destructive test. The information gathered combined with the application temperature is used to calculate the part’s derating factor.

- d. It is unacceptable to use a part just because it passed screening to temperature extremes. Furthermore, these kinds of screens will probably over-stress the parts.

Conclusion

Military applications use commercial microcircuits with no restrictions other than design and performance requirements.

Commercial microcircuits are beginning to be designed into military applications beyond the microcircuit data sheet ambient temperature range.

Functional design for an application will not automatically give a system acceptable *reliability and maintainability*. In some cases such as a high-speed CPU, *the reliability or maintainability* is also tied to the *reliability and maintainability* of the cooling fan attached to its surface. Something besides the function is required to assure operation through a critical mission and for the entire life cycle.

When using commercial parts in military applications NAVSEA – Crane recommends:

1. First, define the environment (i.e., application temperature, moisture, salt, etc.).
2. Design to the part's true-characteristics; not the data sheet range, unless that is acceptable.
3. Select by junction temperature not ambient range.
4. Use JEDEC 51 Test Method to verify the part's temperature characteristics.
5. When screening for a part's temperature characteristic use JEDEC 51 Test Method.
6. DSCC should control suitability of test labs that screen commercial parts for military applications.
7. Only select parts that meet the application ambient and part junction temperature calculated with the application's airflow volume.
8. Derate parts to meet application and part junction-temperature limit.
9. Control parts used beyond their recommended boundaries through a government IPT and/or DSCC. In addition, establish a risk assessment for the application.

10. Use the term *uprating* as a general concept not a specific requirement. Use the terms re-characterize or derate when specifically required. Re-characterization is a good term to use in place of *uprating* when stated as a requirement.
11. The contractor, not the government, is responsible for parts designed and used beyond their warranty in an application. The government's concern is managing risk, logistic support and getting the best value product.
12. Military, QML and SMD parts need to be available, for logistic support, with no required screening or quality conformance inspection (QCI) other than for process control. The same as with commercial parts. This would change and establish a new logistic support practice, similar to commercial practices, for DoD. The part manufacturer should control the Military, QML and SMD part manufacturing process. Required tests or screens should be imposed only for an application reason or manufacturing control.